composition of the single quantum well (6), its layer thickness and its strain in the layer structure all serve to define an absorbing effect within a wavelength range, moreover, a saturable effect is defined by the selection of the position within the standing wave of a laser resonant cavity, wherein an absorption maximum for the laser wavelength λ_L is achieved by setting the lattice strain of the single quantum well and wherein said lattice strain lies in a range that is defined by the lattice mismatch between said single quantum well and the surrounding material of between 0.005 and 0.02 nm.

REMARKS

Claims 1-5 and 7-26 are pending. By this Amendment, claims 1, 3, and 15 are amended. The amendment of claims 3 and 15 is not intended to narrow the scope of the claims. The amendment of claims 3 and 15 corrects an antecedent reference. The amendment of claim 1 is supported by the specification, for example, with respect to the description of Fig. 3 from page 21 to 23. No new matter is introduced by the amendment.

Claim Objections

Claims 11 and 19 were objected to under 37 CFR 1.75(c). The Examiner stated that the claims merely recite a method of forming the device.

However, as disclosed in the specification at page 15 in the first full paragraph, by forming the quantum well at temperatures less than 500° C, a quantum well structure is created so as to reduce the lifetime of the charge carrier such that the structure can be used to generate short laser pulses. The quantum well formed below 500° C ensures that the saturable absorber supplies adequately short laser pulses that are advantageous for many technical applications in the range from 1 to 10 picoseconds. Thus, a low temperature layer refers to a specific composition of matter with identifiable properties, namely a material having charge carriers with reduced lifetimes. As such, the features in these claims do have patentable weight and are proper dependent claims.

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Since the features do specify features of the material, Applicants respectfully request the withdrawal of the objections under 37 CFR 1.75(c).

Claim Rejections Under 35 U.S.C § 112

Claims 1-13, 22, and 24 are rejected under 35 U.S.C. § 112. The Examiner stated that Applicant's use of the term "optional" referring to the intermediate layer and the antireflective layer renders the claim indefinite as to whether the invention requires these layers to be included in the device.

Applicants thank the Examiner for pointing out the potential antecedent reference issues in the claims. Claim 1 has been amended to clarify which layers are included in the layer sequence (3) having a thickness of a whole number multiple of $\lambda_L/2$. The layer sequence (3) of claim 1, having a thickness of a whole number multiple of $\lambda_L/2$, contains a strained-layer single quantum well (6), a cap layer (7), and an optional intermediate layer (9). In the present application, in last paragraph on page 22 of the Detailed Description, the application states in reference to Fig. 3, "The layer sequence 3 should especially be a whole-number multiple i, with i=1, 2, 3, ... and having an optical thickness of $\lambda_L/2$, whereby as a rule, i selected as 1, 2, or 3 is sufficient." Therefore, because the layer sequence (3) of claim 1, having a thickness of a whole number multiple of $\lambda_L/2$, does not include the antireflective layer (8), the optional antireflective layer (8) has been cancelled from claim 1 for clarity.

Applicants use the term "optional" in claim 1 to state that the layer sequence (3) has a thickness of a whole number multiple of $\lambda/2$, regardless of whether or not the layer sequence comprises an intermediate layer. The intermediate layer is clearly not required as part of the layer sequence. It is included in the claim merely to show that a layer sequence, regardless of whether or not it includes the optional intermediate layer, has a thickness of a whole number multiple of $\lambda/2$. It is clear by the use of the term optional that the intermediate layer is not required.

With respect to the dependent claims, for the embodiments within these claims, the specified layer is present even though the independent claim covers embodiments in which the optional layer may or may not be present. Applicants have amended claim 3 to clarify that when the intermediate layer is present, it is the optional intermediate layer of claim 1.

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The Examiner also rejected claim 15 under 35 U.S.C. § 112. Claim 15 has been amended to have proper antecedent basis.

Based on the above comments, the claims are clear. Applicants respectfully request withdrawal of the rejection under 35 U.S.C. § 112.

Claim Rejections Under 35 U.S.C § 102

Claim 1-5, 7, 9-26 are rejected under 35 U.S.C. § 102 as being anticipated by Weingarten et al. (United States Patent No. 6,393,035). Applicants respectfully request reconsideration of the rejection based on the following comments.

Weingarten et al. does not does not show every element of the claimed invention. *See In re Bond*, 910 F.2d 831, 832 (Fed. Cir, 1990) ("For a prior art reference to anticipate in terms of 35 U.S.C. § 102, every element of the claimed invention must be identically shown in a single reference."); *see also* MPEP § 2131. As explained below, the device according to and disclosed in Weingarten et al. does not contain a strained quantum well.

A quantum well of a quantum well heterostructure, e.g., GaAs/$In_xGa_{1-x}As$/GaAs, is not inherently strained. A strained layer is characterized in that the mismatched layer, or quantum well, is sufficiently thin for the particular composition that the difference in lattice constants of the constituent materials is accommodated by elastic strain rather than by the generation of misfit dislocations. *See* Kolbas et al., *Strained-Layer InGaAs-GaAs-AlGaAs Photopumped and Current Injection Lasers*, IEEE Journal of Quantum Electronics, Vol. 24, No. 8, August 1988, pp. 1605 ("Kolbas et al."), a copy of which is enclosed.

A strained-layer structure can be created in a GaAs/$In_xGa_{1-x}As$/GaAs system, provided that the quantum well thickness does not exceed a certain composition-dependent critical thickness. However, if the quantum well exceeds the critical thickness, dislocations form at the growth surface and propagate to the mismatched interface, i.e., the GaAs/$In_xGa_{1-x}As$ interface, such that the layer is no longer strained.

The Matthews-Blakeslee theory, which uses a force-balance approach to calculate a critical thickness curve, is widely used to determine the critical thickness of quantum well heterostructures. *See* Kolbas et al. The Matthews-Blakeslee method has been confirmed for GaAs/$In_xGa_{1-x}As$/GaAs systems. For example, Helmut Brech confirmed the Matthews-

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Blakeslee critical thickness model for GaAs/$In_xGa_{1-x}As$/GaAs systems. *See* Helmut Brech, Optimization of GaAs based High Electron Mobility Transistors by Numerical Simulations, (1998) (thesis) ("Brech Thesis"), a copy of which is enclosed[1]. The Brech Thesis confirmed the Matthews-Blakeslee critical thickness model by plotting various data points for a GaAs/$In_xGa_{1-x}As$/GaAs system on a graph with the Matthews-Blakeslee critical thickness line. *See* Brech Thesis, Fig. 2.5. As can be seen in Fig. 2.5, quantum wells above the Matthews-Blakeslee line exhibited a high dislocation density whereas quantum wells below the plotted Matthews-Blakeslee line exhibited a low dislocation density. Quantum wells with a low dislocation density are generally strained and quantum wells with a high dislocation density are not strained because the lattice mismatch is relieved by the generation of misfit dislocations.

The specific structures disclosed in the Weingarten et al. patent do not have strain. The absorber layer according to Weingarten et al. has a composition and thickness such that the thickness is clearly beyond the critical point. In particular, the "absorber" layer disclosed in the Weingarten et al. reference is described in col. 13, lines 9-30. The Examiner recited absorbing layer 44 as a quantum well. The absorber layer has 25% indium and an absorber layer thickness of 15nm. By evaluating the absorber layer according to Weingarten et al. based on Fig. 2.5 in the Brech Thesis, it can be seen that the absorber layer is clearly above the Matthews-Blakeslee critical thickness and is therefore not a strained quantum well.

Therefore, because Weingarten et al. does not disclose a strained quantum well, Weingarten et al. is not an anticipating reference. With respect to the features of the dependent claims noted by the Examiner, Applicants do not comment on these although they do not acquiesce in the Examiner's assertions. The features of the dependent claims are presently moot in view of the patentability of claim 1. Applicants respectfully request withdrawal of the rejection of claims 1-5, 7, and 9-26 as anticipated by Weingarten et al. (United States Patent No. 6,393,035) under 35 U.S.C. § 102(b).

[1] Applicants have only attached a portion of the Brech Thesis to this response. The full thesis can be found on the Internet at http://www.ue.tuwien.ac.at/publications/PhD%20Theses/brech/diss.htm.

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Rejection Of Claim 8 Under 35 U.S.C § 103

The Examiner rejected claim 8 as being unpatentable over Weingarten et al. (United States Patent No. 6,393,035) in view of Cunningham et al. (U.S. Patent No. 5,701,327) under 35 U.S.C. § 103(a). Examiner states that Cunningham shows that using GaAs and AlAs as quantum well materials is known in the art. Applicants respectfully request reconsideration of the rejection based on the following comments.

With respect to claim 1 and claims depending from claim 1, the deficiencies of the Weingarten et al. patent are discussed above. Specifically, the Weingarten et al. patent does not disclose a *strained* quantum well. Furthermore, Cunningham describes at column 3, lines 21-23, "an interface containing a high number of dislocations is formed between the mirror structure and the strain relief layer. The QW's lie in this high defect region." Since the strain relief layer is designed to avoid strain, this suggests that the quantum well is not strained. As stated above, the single quantum well of Applicants' claimed invention has an indium percentage and a quantum well thickness such that the quantum well is strained.

Because neither of the cited references disclose a strained quantum well, the combined disclosures of the cited references do not teach or suggest a strained quantum well of Applicants' claim 1. Furthermore, there is no motivation to combine the references since Weingarten et al. teaches a half-wave layer of GaAs while Cunningham et al. teaches InP to induce dislocations. There is no teaching in the references to expect these materials to perform as substitutes for each other. With respect to the other features discussed by the Examiner, these issues are presently moot, although Applicants' do not acquiesce in the assertions in the Office Action.

Therefore, because the combined disclosures of Weingarten et al. and Cunningham do not teach or suggest all of the elements of Applicants' claimed invention and because there is no motivation to combine their teachings as suggested, the combined disclosures of the cited references do not render claim 1 or any claims depending from claim 1 obvious. Because claim 8 depends from claim 1, Applicants respectfully request withdrawal of the rejection of claim 8 as being unpatentable over Weingarten et al. (United States Patent No. 6,393,035) in view of Cunningham et al. (U.S. Patent No. 5,701,327) under 35 U.S.C. § 103(a).

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CONCLUSION

In view of the foregoing, it is submitted that this application is in condition for allowance. Favorable consideration and prompt allowance of the application are respectfully requested.

The Examiner is invited to telephone the undersigned if the Examiner believes it would be useful to advance prosecution.

Respectfully submitted,

Peter S. Dardi

Peter S. Dardi
Registration No. 39,650

Customer No. 24113
Patterson, Thuente, Skaar & Christensen, P.A.
4800 IDS Center
80 South 8th Street
Minneapolis, Minnesota 55402-2100
Telephone: (612) 349-5746

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